

WHAT IS CLAIMED IS:

① A lens function-including optical fiber comprising:
at least one information transmission optical fiber; and
at least one gradient index optical fiber having an outer
5 diameter equal to that of said information transmission optical
fiber and having a length exhibiting a specific lens function,
said gradient index optical fiber being jointed or contacted
with an end surface of said information transmission optical
fiber.

10 2. A lens function-including optical fiber according to
claim 1, wherein said information transmission optical fiber
is a single mode optical fiber.

3. A lens function-including optical fiber according to
claim 1, wherein said gradient index optical fiber is produced
15 by an ion exchange method.

④ A lens function-including optical fiber according to
claim 1, wherein, when a refractive-index distribution of said
gradient index optical fiber in a wavelength range used is given
by the expression:

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$$n(r)^2 = n_0^2 \cdot \{1 - (g \cdot r)^2 + h_4 (g \cdot r)^4 + h_6 (g \cdot r)^6 + h_8 (g \cdot r)^8 + \dots\},$$

said gradient index optical fiber satisfies a condition:

$$0.1 \leq n_0 \cdot g \cdot r_0 \leq 0.5$$

in which \underline{r} is a distance from an optical axis, $n(r)$ is a refractive
index in a position at the distance \underline{r} from the optical axis,

25 n_0 is a refractive index on the optical axis, r_0 is a radius of

said gradient index optical fiber, g is a refractive-index distribution coefficient, and $h_4, h_6, h_8 \dots$ are high-order refractive-index distribution coefficients respectively.

5 5. A lens function-including optical fiber according to claim 4, wherein said gradient index optical fiber satisfies a condition:

$$0.12 \leq n_0 \cdot g \cdot r_0 \leq 0.25.$$

10 6. A lens function-including optical fiber according to claim 4 or 5, wherein the refractive index n_0 on the optical axis of said gradient index optical fiber is in a range of from 1.40 to 1.80 (both inclusively).

15 7. A lens function-including optical fiber according to claim 4 or 5, wherein the refractive index n_0 on the optical axis of said gradient index optical fiber is in a range of from 1.50 to 1.70 (both inclusively).

20 8. A lens function-including optical fiber according to claim 1, wherein a length of said gradient index optical fiber is in a range of from $0.05P$ to $1P$ (both inclusively) in which P is a periodic length of said gradient index optical fiber.

25 9. A lens function-including optical fiber according to claim 1, wherein the length of said gradient index optical fiber is in a range of from $0.05P$ to $0.5P$ (both inclusively) in which P is the periodic length of said gradient index optical fiber.

10 10. A lens function-including optical fiber according to claim 1, wherein said information transmission optical fiber

and said gradient index optical fiber are joined and fixed to each other in a condition that said two optical fibers are inserted in a sleeve having an inner diameter substantially equal to said outer diameter of said two optical fibers.

- 5 11. A lens function-including optical fiber according to claim 1, wherein said information transmission optical fiber and said gradient index optical fiber are joined and fixed to each other in a groove which is formed in a planar substrate and which is V-shaped in section.

10 12. A method of producing a lens function-including optical fiber, comprising the steps of:

immersing a homogeneous glass rod in molten salt to perform ion exchange to thereby form a refractive-index distribution in said glass rod;

15 forming a gradient index optical fiber with a desired outer diameter by stretching said glass rod while heating said glass rod retained vertically; and

20 cutting said gradient index optical fiber into a length corresponding to a specific periodic length of said gradient index optical fiber.